2015 Fall Outlook for Central and Northern New Mexico

Courtesy: New Mexico Magazine

Courtesy: Lightcentric Photography

A moderate El Niño in April and May quickly strengthened to near the strongest El Niño on record (during the summer months) by mid July. The three-month, June-August average of sea surface temperatures in the Niño 3.4 region (the Oceanic Niño Index (ONI)) was 1.22°C above normal. This is the third-highest June-August value since records started in 1950, behind 1987 (1.36°C) and 1997 (1.42°C). The two-month July-August 2015 Multivariate ENSO Index (MEI) of 2.37 is the second-highest July-August reading on record, second only to 1997. What does the 3rd strongest El Niño in recorded history (since 1871) during the summer months mean for Fall (Oct-Nov) precipitation in New Mexico?

Overview

- A Strong El Niño is currently underway
- Positive equatorial sea surface temperature (SST) anomalies continue across most of the Pacific Ocean.
- There is approximately 95% chance that El Niño will continue through Northern Hemisphere winter 2015-16, gradually weakening through spring 2016.
- Precipitation data from the two most analogous years to 2015 (1982 & 1997) combined with forecasts from the most highly skilled climate forecast models <u>indicate that precipitation in central and northern New Mexico during October and November will most likely be near to slightly above average</u>.
- <u>Snowfall data from 2 previous strong to extreme El Niño events combined with climate model forecasts suggest that snowfall will range from near to above average in October and November, particularly in the higher elevations favored by orographic effects.</u>

Traditional El Niño Induced Weather Pattern

El Niño was first identified by fisherman in the late 19th century off the coasts of Peru and Ecuador (Carranza, 1892; Carrillo, 1893). Unusually high Pacific Ocean temperatures depressed the region's fisheries, and intense rainfall led to coastal flooding. The most extreme El Niño events, in terms of the surface warming in the eastern and central Pacific, occurred during 1982-1983 and 1997-1998 (Ken Takahashi).

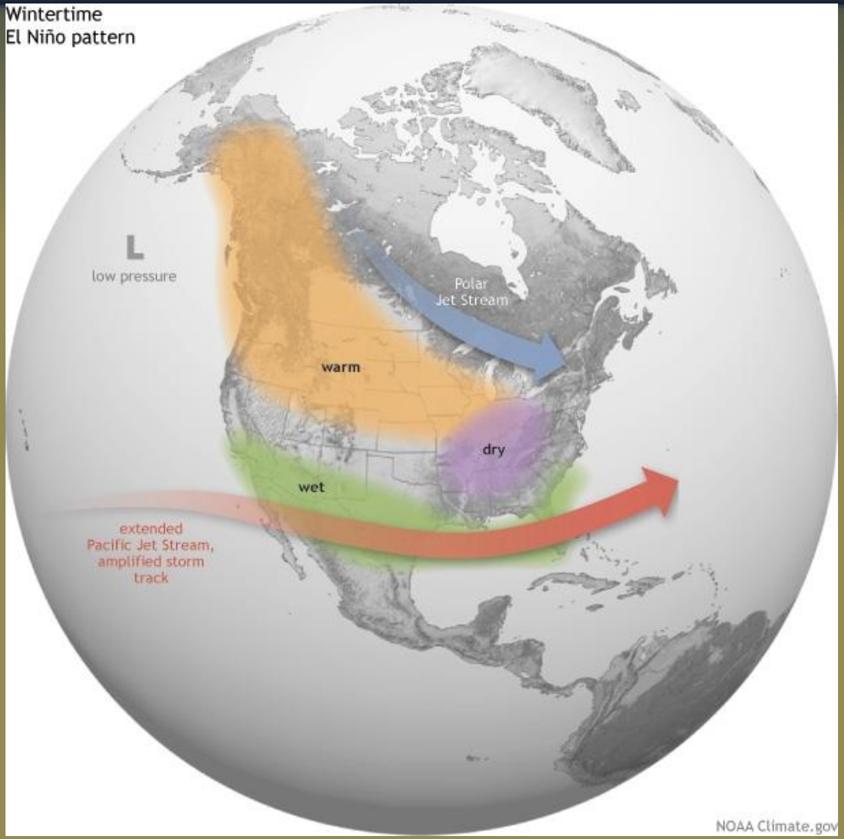
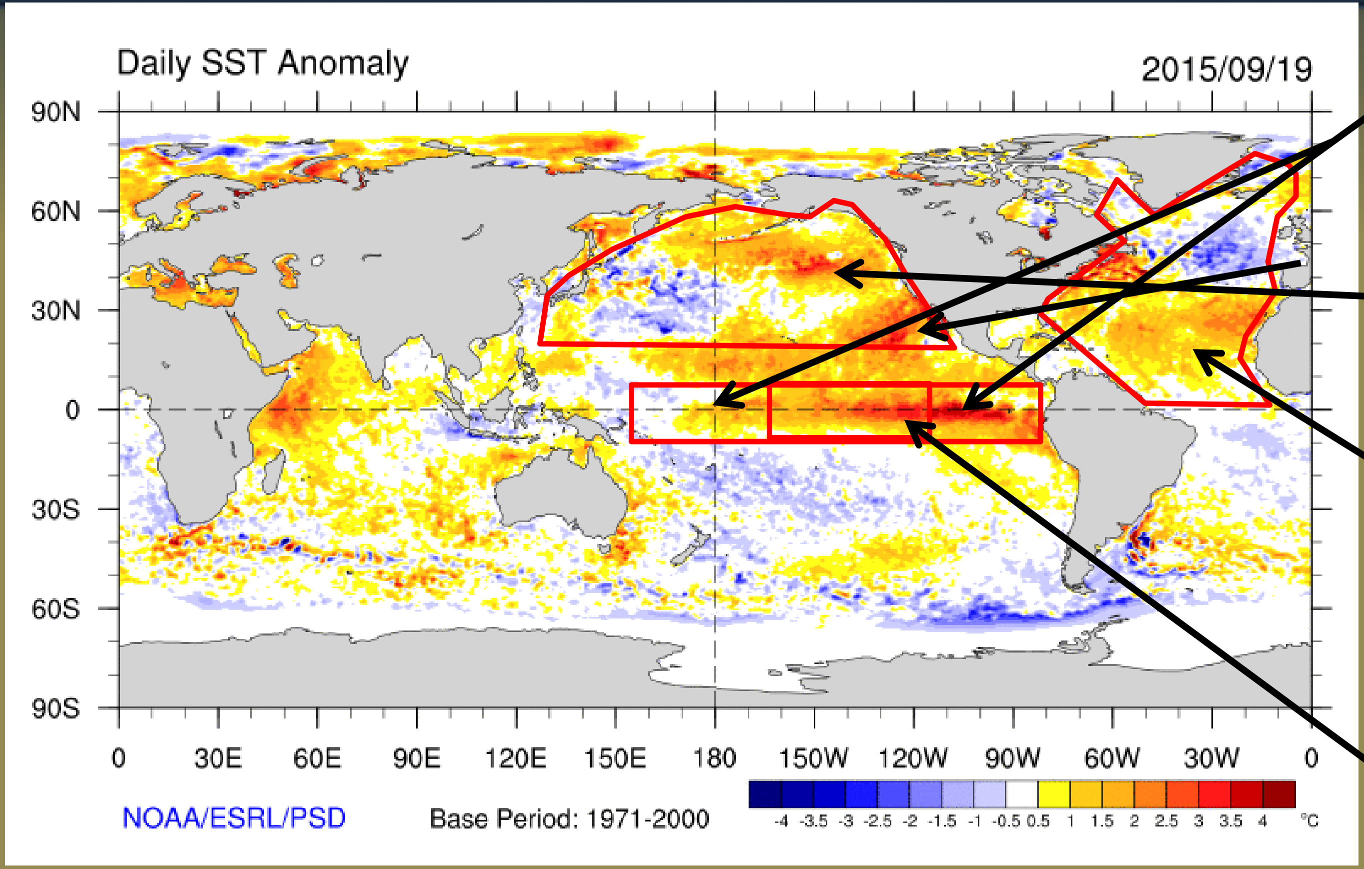


Figure 1. This is the typical upper level pattern we expect toward the end of the Fall season during a traditional moderate El Niño. Warmer than average sea surface temperatures (SSTs) in the central and eastern Pacific Ocean result in more deep convection over these areas. The Pacific Jet stream becomes stronger and once it moves east of the deep convection, seeks balance and splits near the west coast of North America. The southern portion of the split is, at times, stronger than the northern portion and can be more active as well, with an increased storm track frequency over the southwest and southern United States. The southern portion of the split is referred to as the sub-tropical jet stream.

Latest Sea Surface Temperature Observations & Oceanic Oscillation Index Values



- Multivairate ENSO Index (MEI) for JUL-AUG 2014: +2.37
- Pacific Decadal Oscillation (PDO) for AUG 2014: +1.84
- Atlantic Mutidecadal Oscillation (AMO) for AUG 2014: +0.15
- Oceanic Niño Index (ONI) (uses Niño 3.4 region) for JJA 2014: +1.2

Figure 2. Recent SST Anomalies in the Equatorial Pacific Ocean presently lend themselves to a historically strong El Niño that rivals the 1982-83 and 1997-98 events. Therefore, comparisons to past strong to extreme El Niño years 1982 and 1997 are the focus of this outlook.

Sub-surface Observations

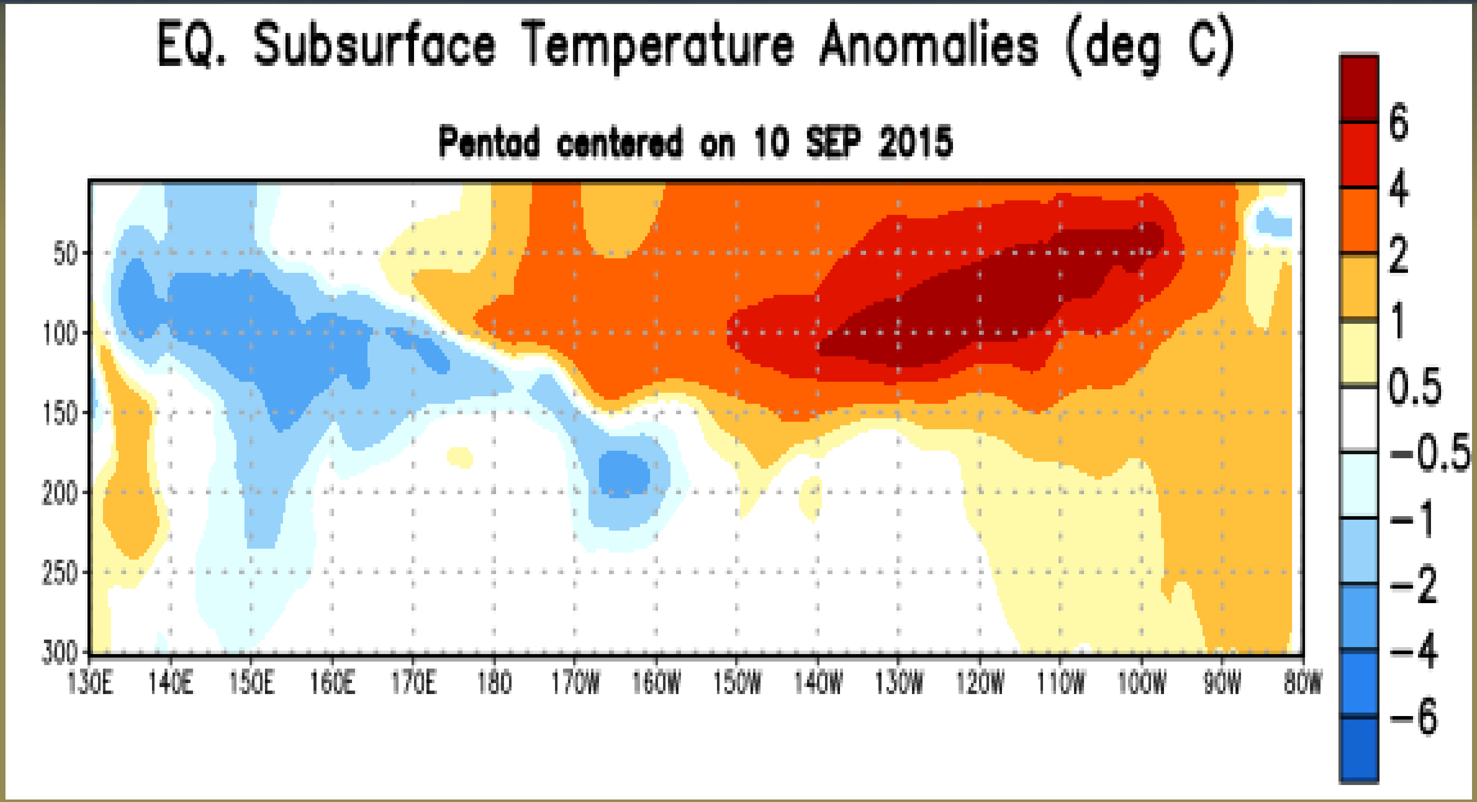
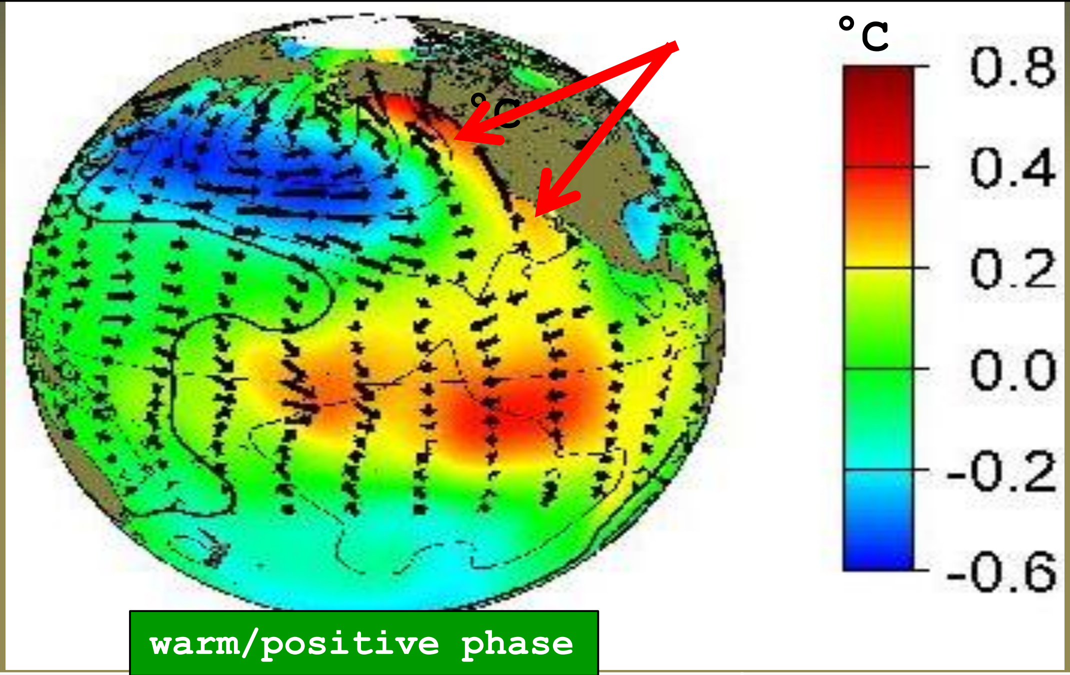


Figure 3. Sub-surface Equatorial Pacific plot indicating that another area of warm water associated with a Kelvin wave will help to keep surface temperatures relatively high for at least several more months. *A Kelvin wave is a wave in the ocean or atmosphere that balances the Earth's Coriolis force against a topographic boundary such as a coastline, or a waveguide such as the equator.*

The Pacific Decadal Oscillation (PDO)

A key factor during a positive PDO is increased low and mid level moisture availability in far northeast Pacific/Gulf of CA.

What's been referred to in the media as "The Blob" (a large area of warm ocean temperatures off the West Coast of the U.S) is associated with the sea surface temperature pattern during the positive/warm phase of the PDO.



PDO Jun, Jul, Aug 2015	PDO Jun, Jul, Aug 1997	PDO Jun, Jul, Aug 1982
1.54, 1.84, 1.56	2.76, 2.35, 2.79	*-0.78, 0.58, 0.39*

Figure 4. Typical Sea Surface Temperature Anomaly (SSTA) patterns and wind stress or the amount of wind force on the water surface (arrows) in the North Pacific Ocean during a positive Pacific Decadal Oscillation phase (PDO). As with the North American Monsoon season, October and November precipitation correlates well with positive PDO values. The closest analog years to 2015 were 1982 and 1997.

Analog Years

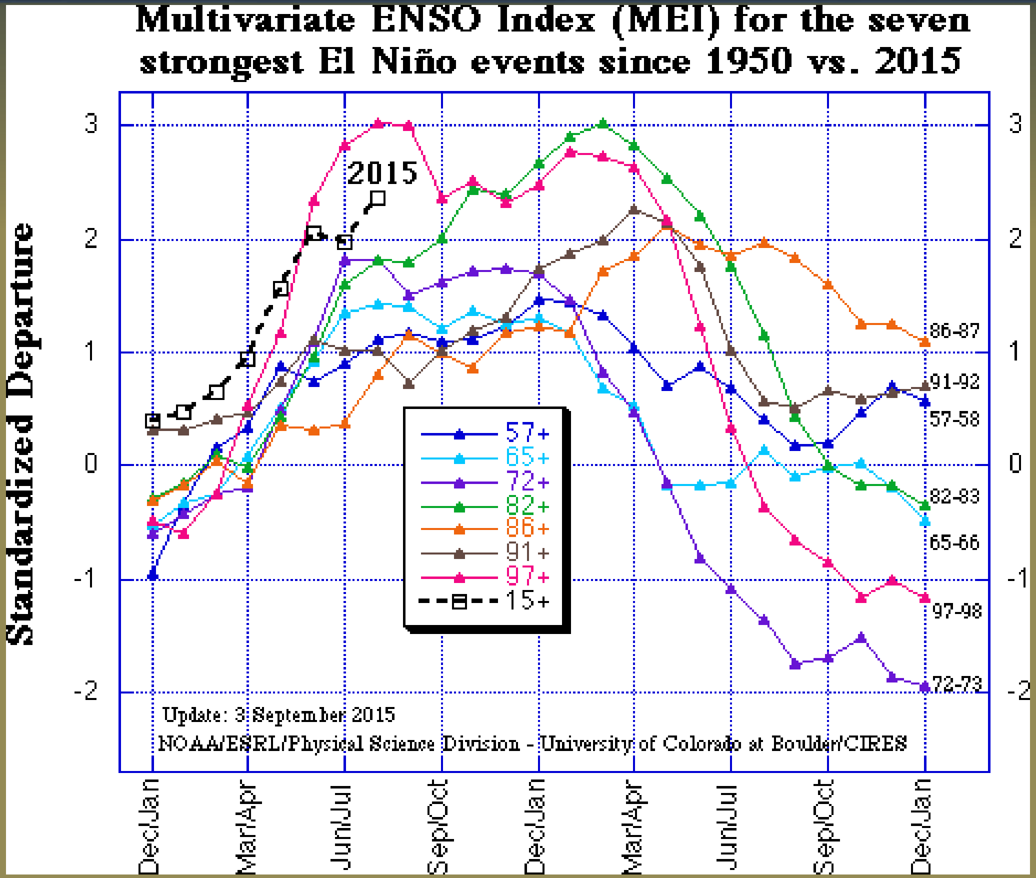


Figure 5. A strong to extreme El Niño event makes identifying analog years relatively easy. The Fall of 1982, and 1997 are the only two years that compare when looking at MEI, Oceanic Niño Index (ONI) and the Pacific Decadal Oscillation (PDO) from previous summer months.

October and November (ON) precipitation in strong/extreme El Niño Years vs. 30-yr Avg.

Green = Above 30-yr Avg | Orange = Below 30-yr Avg.

Site	81'-10' avg Oct-Nov	1997 Oct-Nov	1982 Oct-Nov
ABQ	1.59"	1.05"	0.86"
Santa Fe	2.26"	1.95"	1.95"
Clayton	1.64"	1.51"	0.76"
Gallup	1.86"	1.91"	1.46"
Las Vegas	1.94"	1.02"	2.33"
Roswell	1.82"	1.94"	1.12"
Chama	3.96"	3.70"	4.05"
Eagle Nest	1.90"	1.78"	1.18"
Los Alamos	2.53"	1.75"	2.30"
Taos	1.87"	2.29"	1.66"
Wolf Canyon	3.44"	3.06"	2.80"
Carrizozo	2.14"	1.32"	0.72"
Luna R. S.	2.62"	2.50"	2.19"
El Morro	2.00"	2.43"	1.14"
Sandia Park	3.06"	2.79"	2.63"

Figure 6. The vast majority of sites were slightly below average in ON when a strong El Niño was in place along with a positive PDO index. This rather limited dataset would indicate that a strong to extreme El Niño or much warmer than average sea surface temperatures (SSTs) of at least 1.5°C has a relatively low correlation with respect to precipitation in central and northern New Mexico during ON.

Graph of Precipitation Data

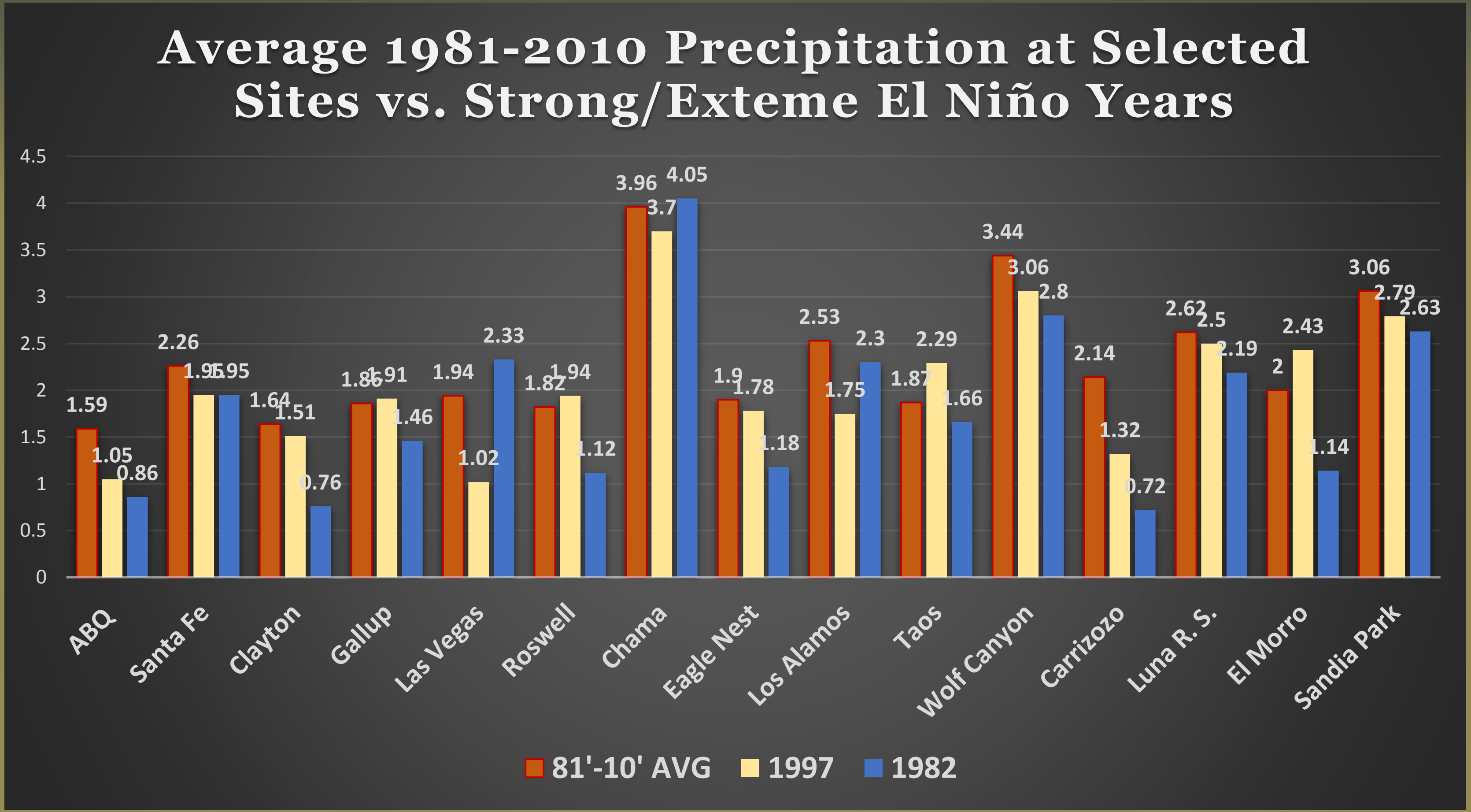


Figure 7. Graphical representation of data from Figure 6. To reiterate, most sites were near to slightly below their 30-year climatological averages. Note that the vast majority of higher elevations sites were near average whereas lower elevations did not fair as well compared to their 30 year averages indicating that perhaps precipitation originated from large-scale mid-latitude cyclones and was more orographic in nature.

October-November Snowfall

Green = Above 30-yr Avg | Orange = Below 30-yr Avg.

Site	81'-10' Avg Oct-Nov	1997 Oct-Nov	1982 Oct-Nov
ABQ	1.6"	1.1"	0.9"
Santa Fe	3.9"	3.8"	0.5"
Clayton	4.6"	M	4.2"
Gallup	5.6"	8.9"	1.1"
Las Vegas	6.5"	13.9"	8.3"
Roswell	1.8"	M	7.1"
Chama	14.8"	10.5"	14.8"
Eagle Nest	8.2"	15.2"	9.5"
Los Alamos	8.0"	16.0"	8.8"
Taos	3.5"	3.0"	1.4"
Wolf Canyon	15.4"	29.0"	18.0"
Carrizozo	0.7"	0.1"	0.0"
Luna R. S.	1.1"	3.0"	0.0"
El Morro	6.9"	16.3"	1.5"
Sandia Park	10.9"	6.0"	8.3"

Figure 8. Most higher elevation sites were above average snowfall in ON when a strong El Niño was in place along with a positive PDO index. This rather crude dataset would indicate that strong El Niño conditions or much warmer than average sea surface temperatures (SSTs) of at least 1.5°C have some correlation with respect to snowfall in central and northern New Mexico during Oct-Nov.

October-November Snowfall

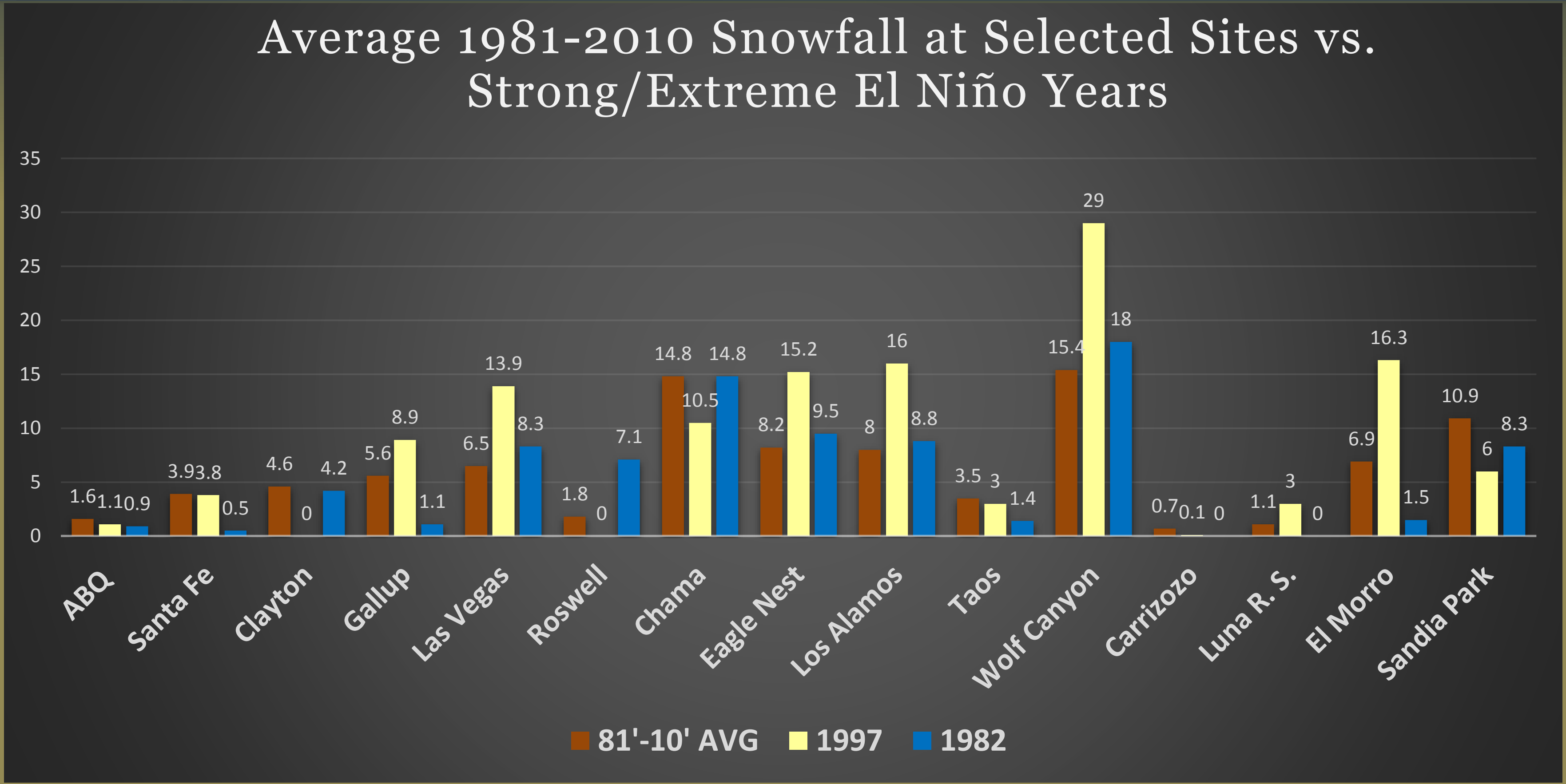


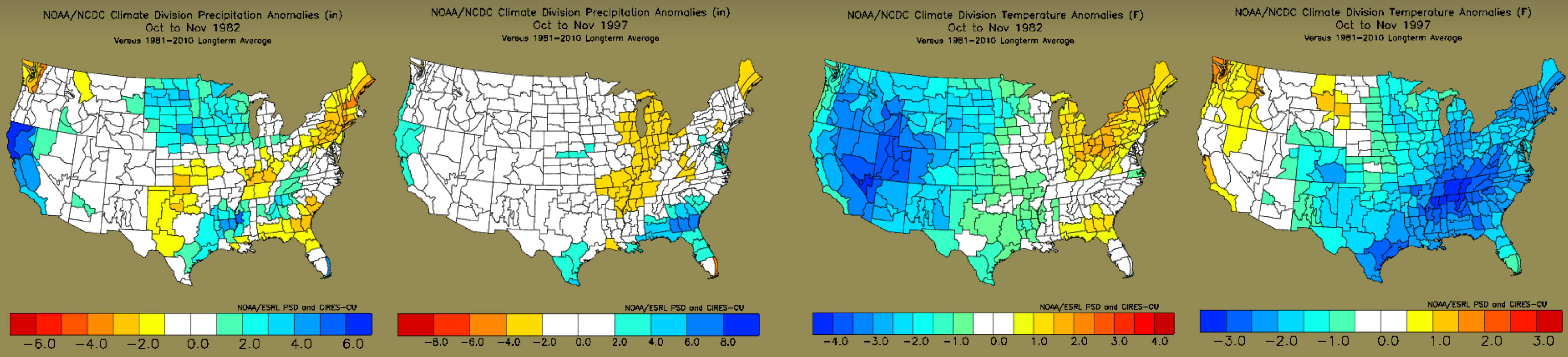
Figure 9. Graphical representation of data from Figure 8. To reiterate, most higher elevation sites were above their 30-year climatological snowfall averages during Oct-Nov, particularly in 1997.

How Much of the Precipitation That Fell Was Snow?

Site	%
ABQ	10%
Santa Fe	2%
Clayton	50%
Gallup	7%
Las Vegas	32%
Roswell	58%
Chama	33%
Eagle Nest	73%
Los Alamos	35%
Taos	8%
Wolf Canyon	58%
Carrizozo	0%
Luna R. S.	0%
El Morro	12%
Sandia Park	29%

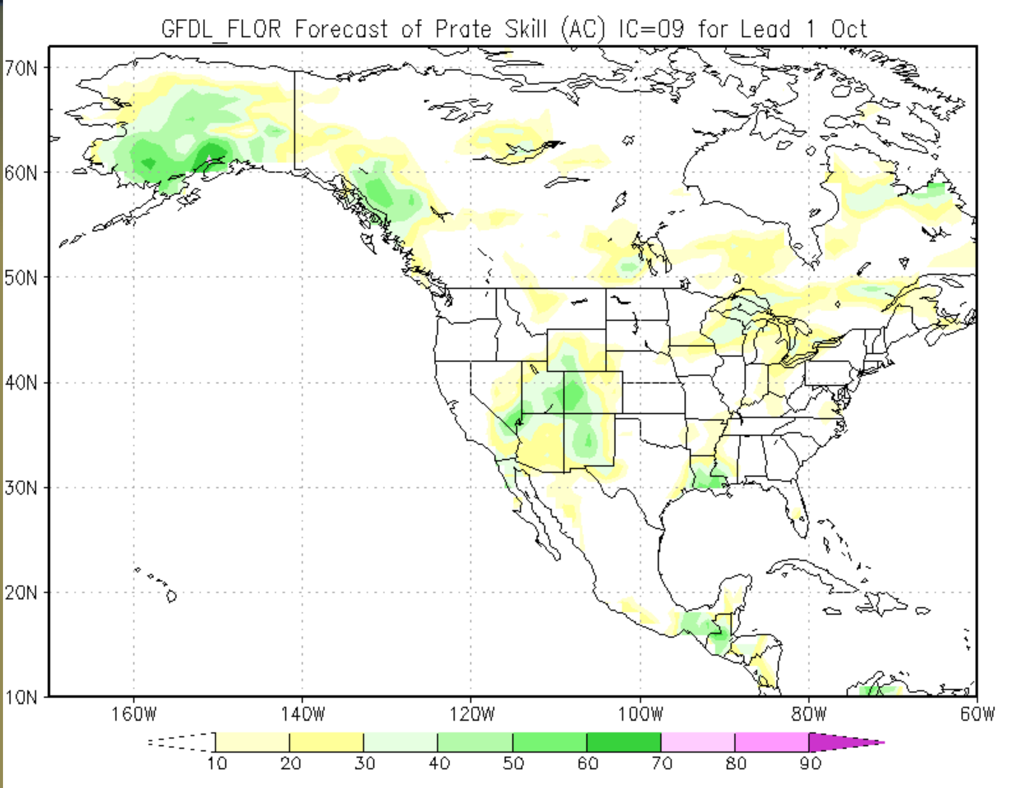
Figure 10. Percentage of precipitation that fell as snow at each site. This data suggests that a strong backdoor cold front must have dropped into the eastern plains in O-N 1982 to lower snow levels down to the lower Pecos River valley/Roswell area.

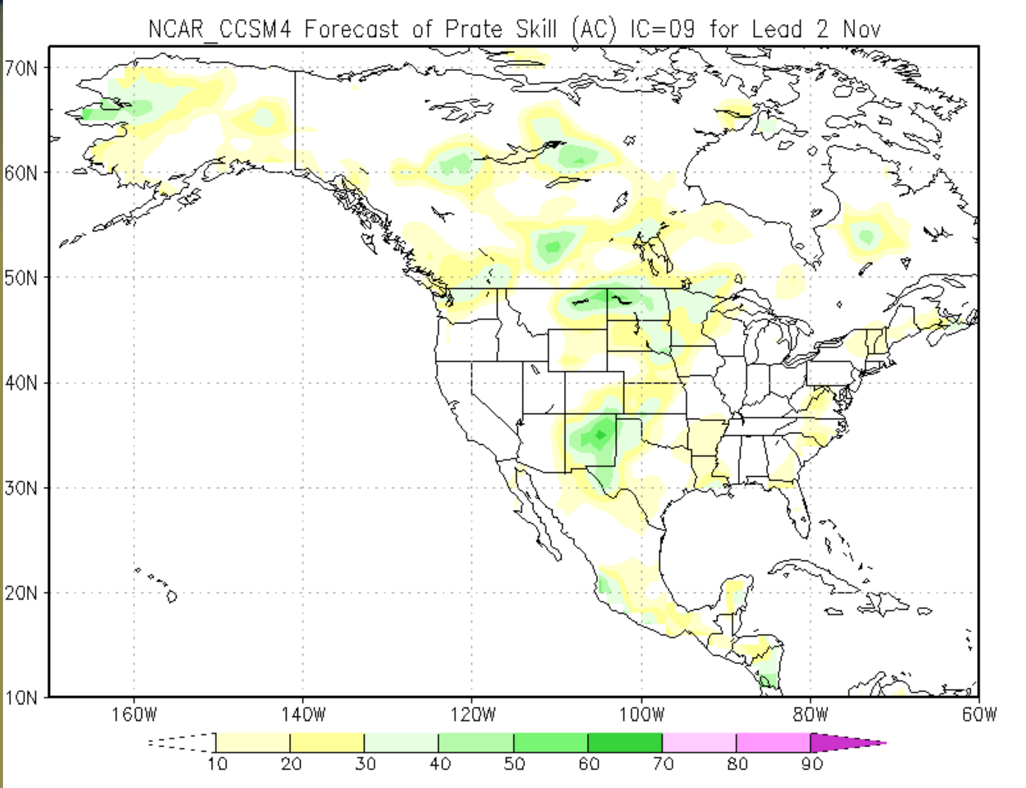
Precipitation and Temperature Anomalies from ON 1982 and 1997 El Niño Events



Figures 11-14. Precipitation and Temperature anomaly plots for CPC's climate divisions comparing the two strong/extreme El Niño years (1982 & 1997) with 30-year climatological averages. All climate divisions in New Mexico are near average for precipitation in October and November while the entire state is slightly below average to below average with regard to temperature.

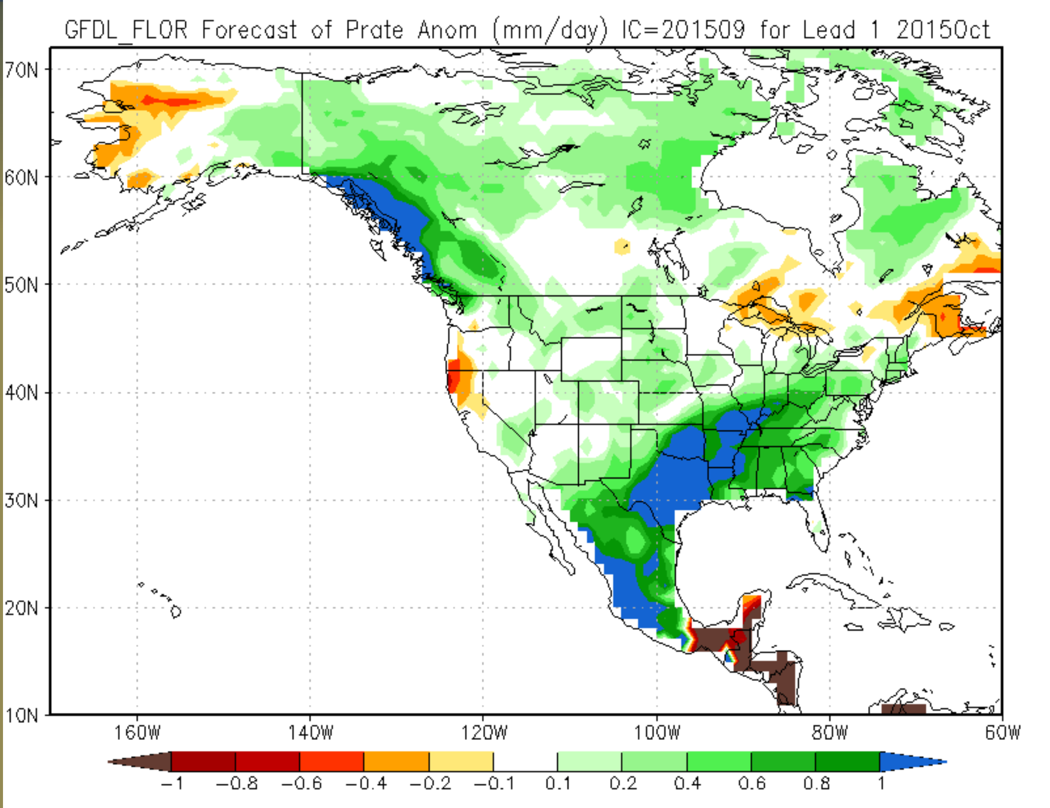
Climate Model Skill Scores

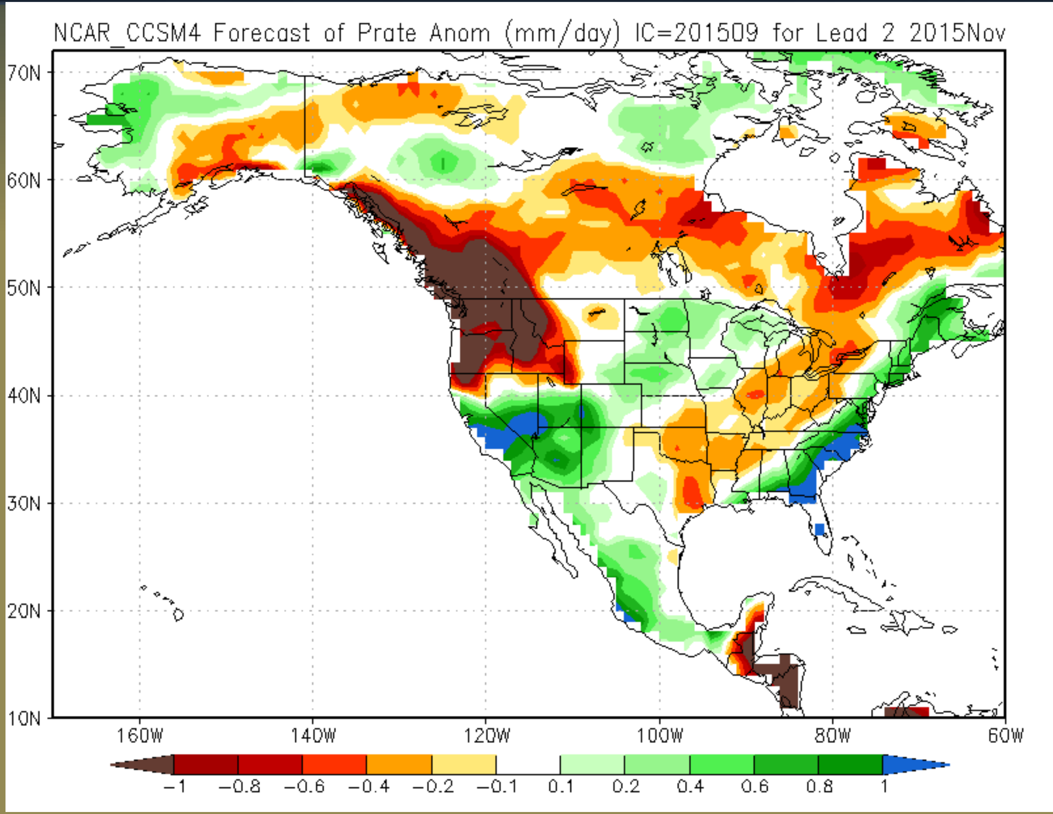




Figures 15 & 16. Geophysical Fluid Dynamics Laboratory (GFDL) and the National Center for Atmospheric Research (NCAR) climate model skill scores for October and November, respectively. These two climate models have the highest skill scores with regard to precipitation forecasts in New Mexico during October and November.

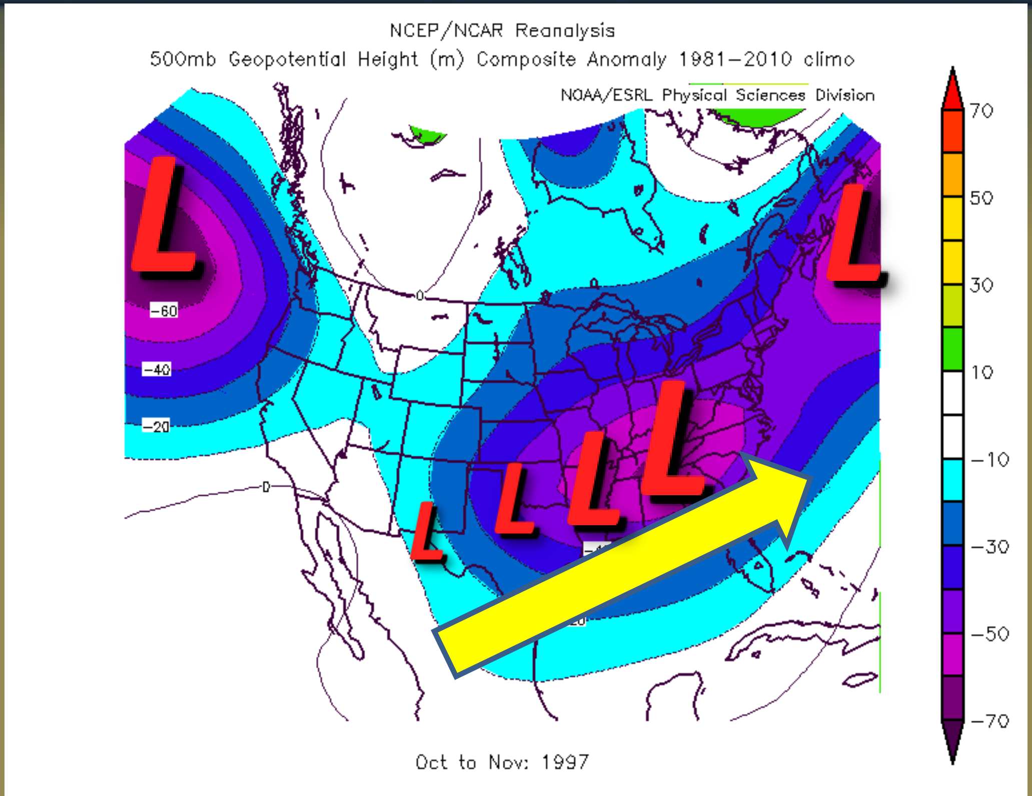
Climate Model Forecasts

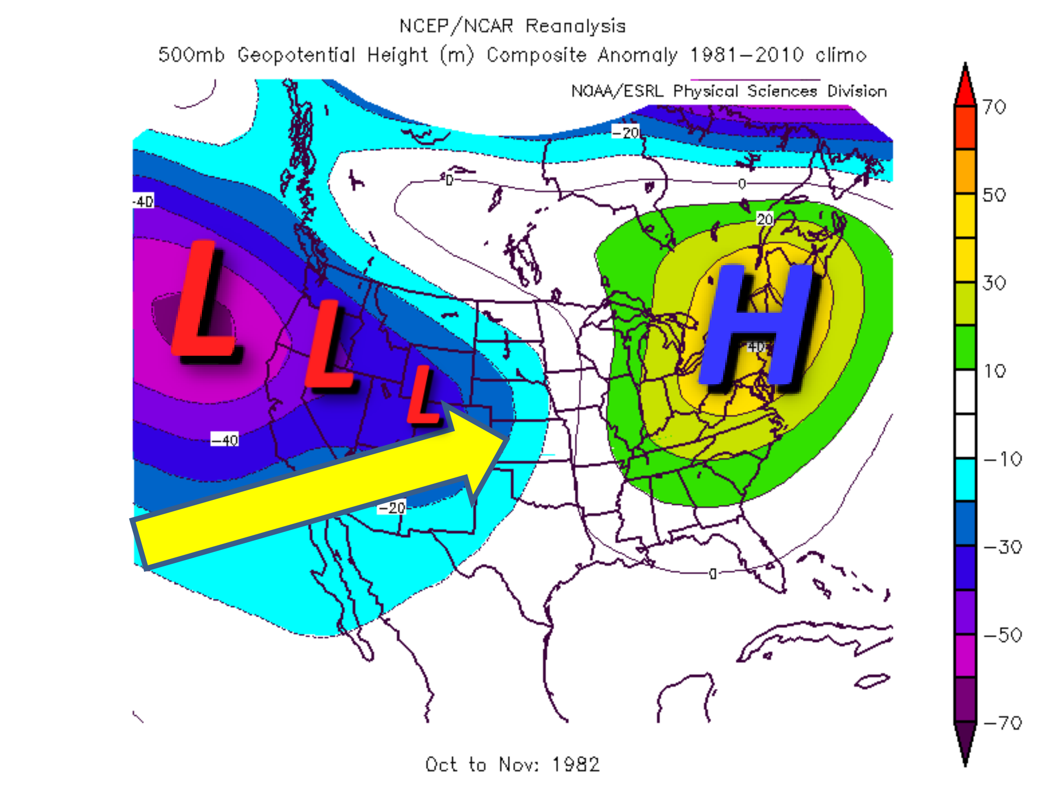




Figures 17 & 18. Precipitation rate (millimeters per day) anomaly forecasts for October (left) and November (right) 2015 from the two most skilled climate models for New Mexico. Note that the GFDL model predicts above average precipitation over southeast New Mexico eastward to the southern plains and deep south in October. The NCAR Community Climate System Model version 4 favors western New Mexico and points west in November.

Differences Between 1982 and 1997





Figures 19 & 20. 500mb Height Anomalies from October-November 1997 and 1982. Note that the upper level height pattern between the strong/extreme El Niño of 1982-83 and 1997-98 were quite different. In 1997, heights over the southern states were lower than average indicating more upper level trough passages and a strong subtropical jet stream (more in line with the NCAR climate model forecast for Nov in previous slide). In 1982, deeper than average upper level troughs along the West Coast likely moved eastward through the Great Basin into the Central Rockies, keeping New Mexico on the breezy and dry side of the jet stream. These plots help explain why Oct-Nov 1997 was wetter in the northern two thirds of New Mexico than Oct-Nov 1982.

Fall Precipitation & Temperature Outlooks from CPC

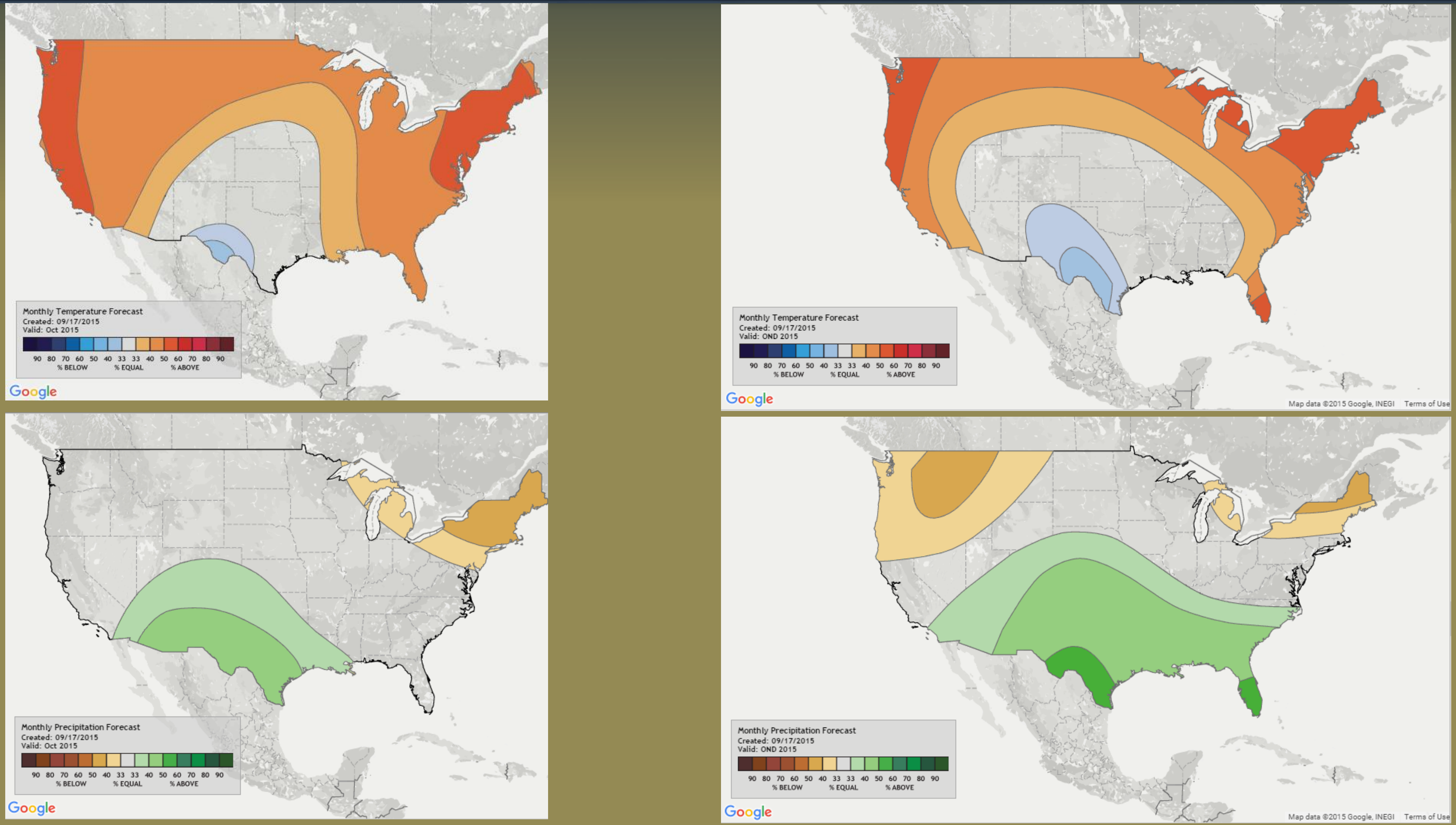


Figure 21-24. Climate Prediction Center's 2015 October Temperature and Precipitation Outlook (left) and October-November-December Temperature and Precipitation Outlook (right) which incorporate both dynamical climate prediction model data as well as previous precipitation and temperature statistics to derive a seasonal forecast. In general, greater than average chances for above average precipitation is forecast for the southwestern United States. Slightly higher chances for below average temperatures are forecast for northern half of NM.

Latest Climate Model Forecasts

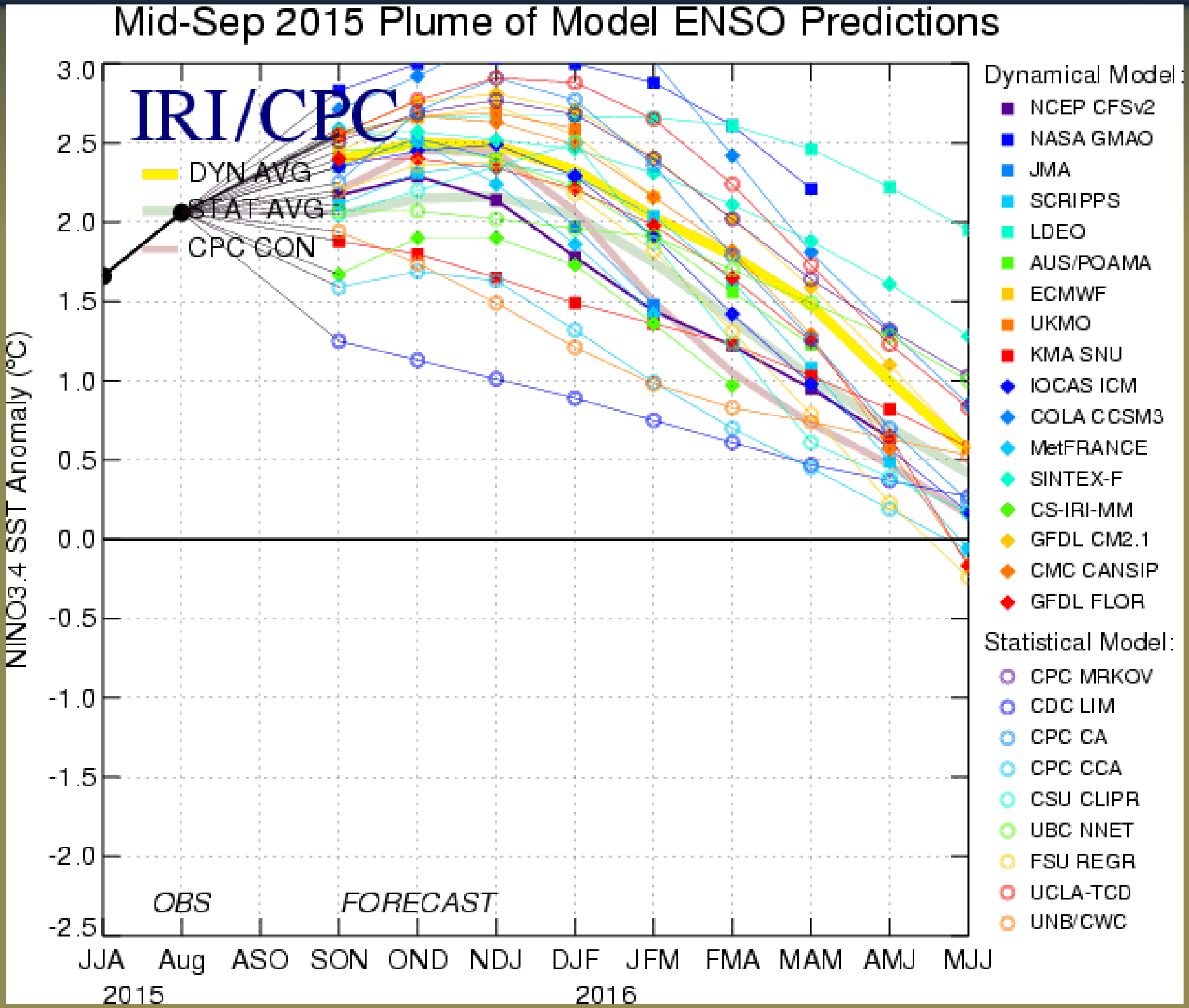


Figure 25. The majority of models favor strong El Niño conditions (1.5°C- 2.0°C) continuing through Winter, the weakening during Spring 2016.

What About Wind During the First Two Weeks of October?

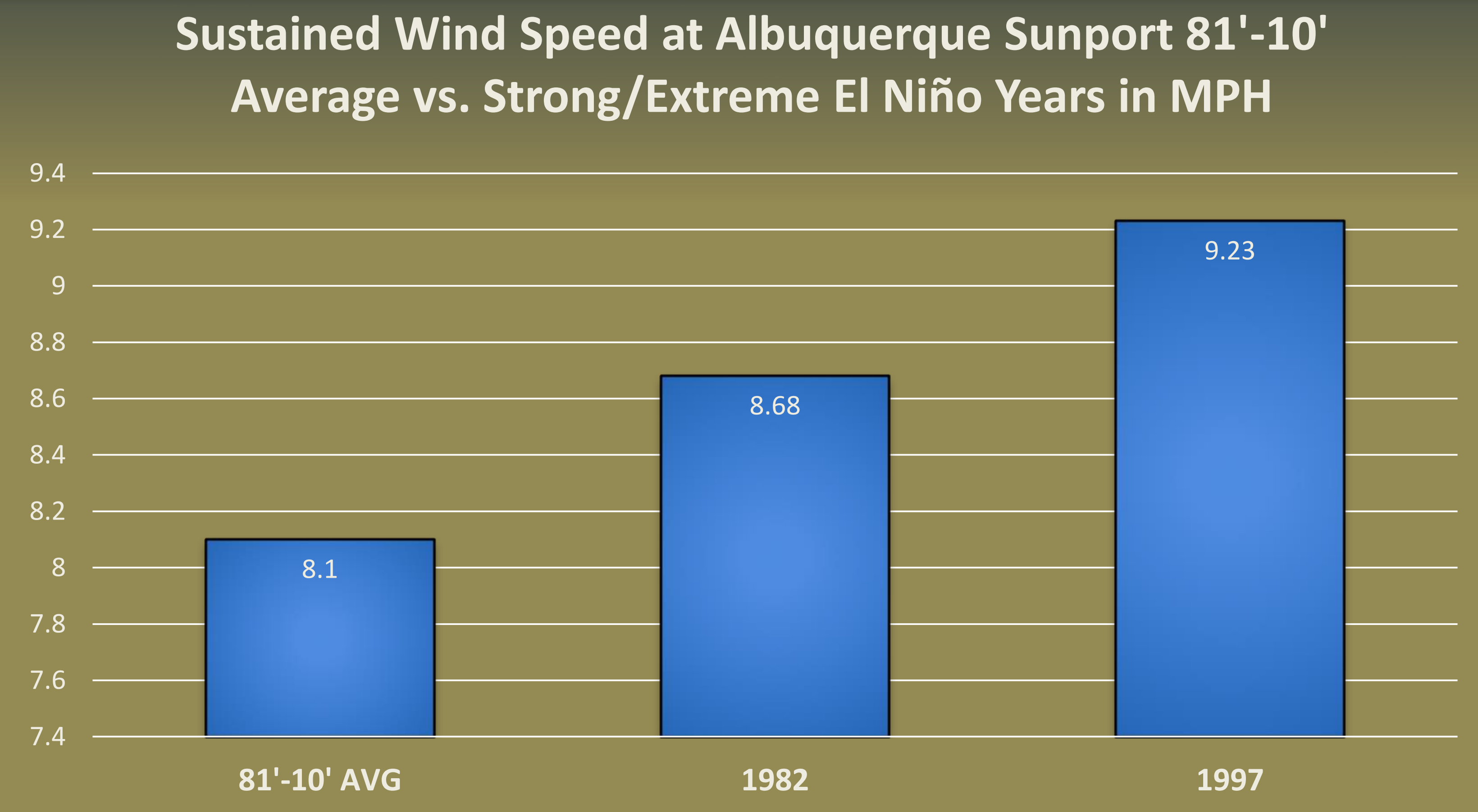
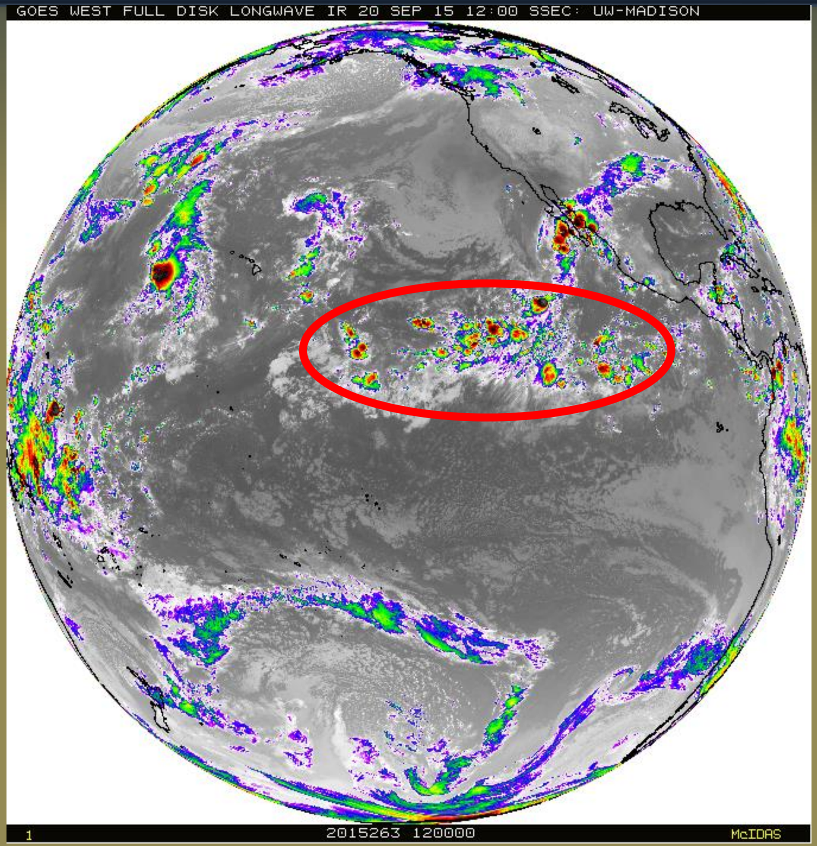


Figure 26. 1981-2010 Climatological sustained wind speed during the first two weeks of October at the Albuquerque Sunport versus strong/extreme El Niño Years. Sustained wind speeds were higher than average during the first two weeks of October in both strong/extreme El Niño years.

What Happened in August & Early September?



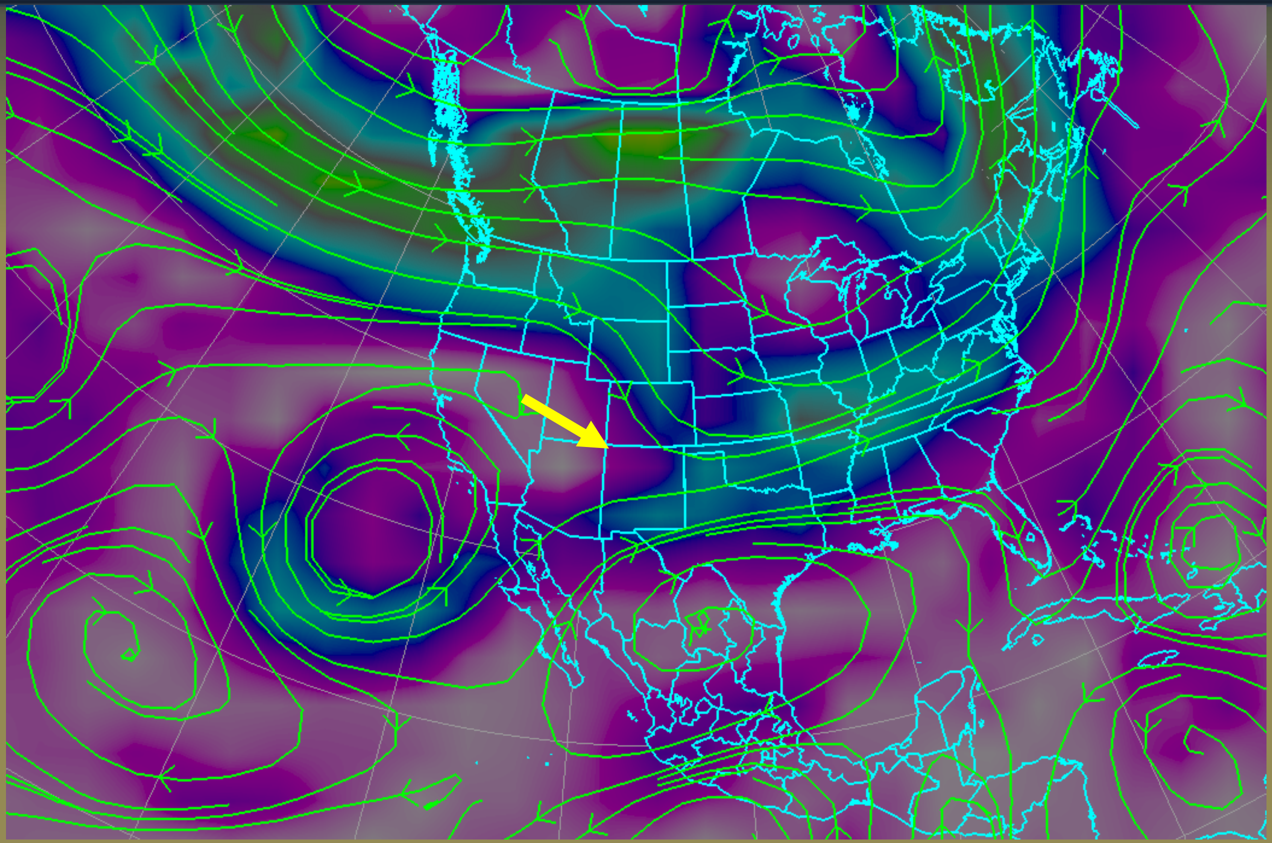


Figure 27 & 28. Enhanced Infrared Satellite image from GOES-W September 20, 2015 (left) and 300mb GFS Analysis Wind speed and direction (right). El Niño strengthened rapidly in June and July, resulting in widespread deep tropical convection in the eastern Pacific Ocean (left). As a result of this deep convection, temperature differences in the upper atmosphere between high latitudes and the tropics increases. This stronger than average temperature difference or gradient resulted in a stronger polar jet stream (right) and more frequent dry air intrusions into New Mexico the west and northwest during August and early September.

How about the Rest of September?

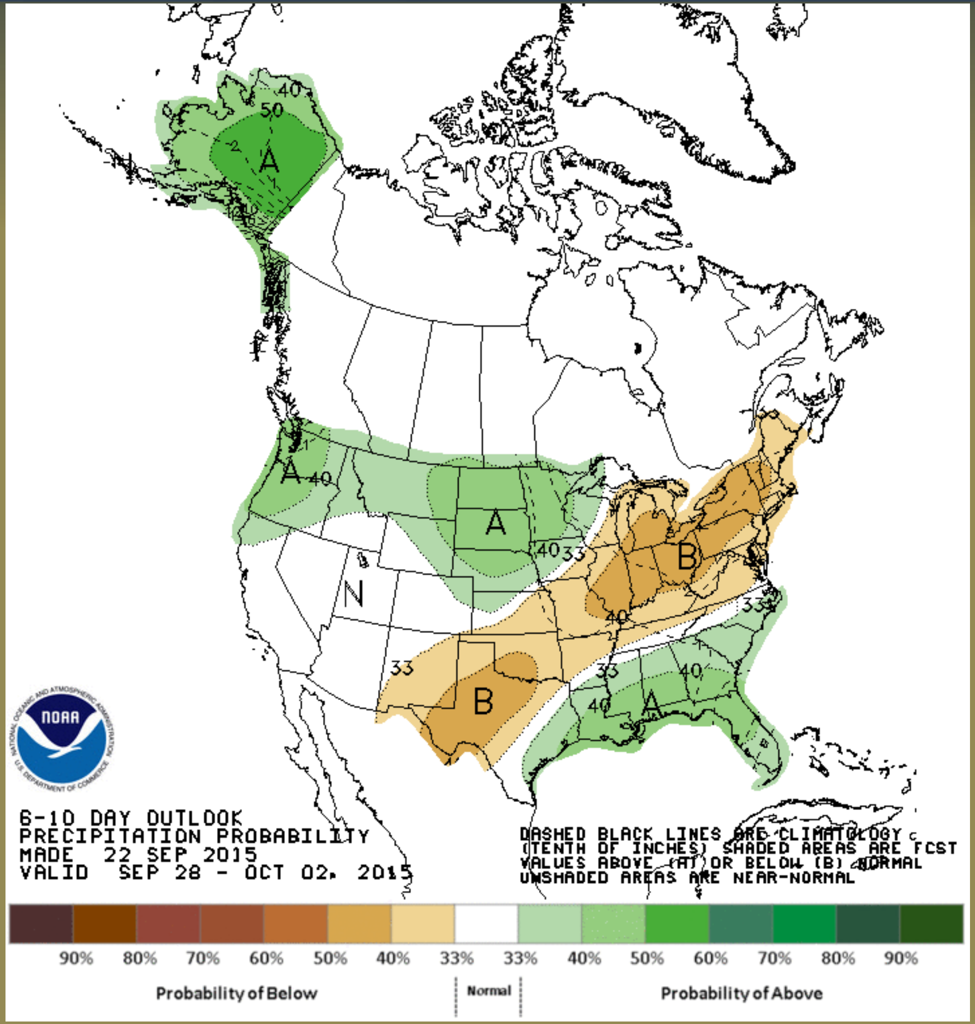


Figure 29. Medium Range Global Numerical Weather Prediction Models suggest that after the recent bout with wet weather, the remainder of September will most likely be on the dry side.

Summary

- Precipitation in previous Fall (ON) seasons during the onset years of a strong/extreme El Niño events since 1871 ranged from slightly below to slightly above the 1981-2010 climatological averages at sites throughout northern and central New Mexico.

- Precipitation data from the two most analogous years to 2015 (1982 & 1997) combined with forecasts from the most highly skilled climate forecast models indicate that precipitation in central and northern New Mexico during October and November will most likely be near to slightly above 1981-2010 climatological averages.

- Snowfall data from the 2 previous strong to extreme El Niño events combined with climate model forecasts suggest that snowfall will range from near to above average in October and November, particularly in the higher elevations favored by orographic effects.

- Keep in mind that each El Niño event is different. The two strong to extreme El Niño events in 1982 and 1997 were significantly different from one another. Current observations of low level trade winds and SSTs suggest that this event will be somewhere in-between the 1982 and 1997 events.

- *The 2015-16 Winter (Dec-Feb) Outlook for Central and Northern New Mexico will be out in mid October.

Outlook Information

- **Outlook provided by National Weather Service Forecast Office Albuquerque, NM.**

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